

A. SUMMER FLOUNDER ASSESSMENT SUMMARY FOR 2005

State of Stock: The summer flounder stock is not overfished, but overfishing is occurring relative to the biological reference points. The fishing mortality rate has declined from 1.32 in 1994 to 0.40 in 2004 (Figure A1). The 80% confidence interval for F in 2004 ranges from 0.34 to 0.49. Retrospective analysis shows that the current assessment method tends to underestimate recent fishing mortality rates (Figure A4). The overfishing reference point $F_{\text{threshold}} (= F_{\text{max}})$ was previously estimated to be 0.263 (Terceiro 1999; MAFMC 1999) (Figures A1, A3). For the present assessment, the updated estimate of $F_{\text{threshold}} (= F_{\text{max}})$ is 0.276 (Figures A1, A3).

Total stock biomass (TSB) has increased substantially since 1989, and was estimated to be 54,900 mt on January 1, 2005. The 80% confidence interval for total stock biomass on January 1, 2005 ranged from 49,300 to 62,100 mt. The biomass threshold reference point ($\frac{1}{2}TSB_{\text{MSY}}$) was previously estimated to be 53,200 mt (Terceiro 1999; MAFMC 1999) (Figures A2, A3). For the present assessment, the updated estimate of the biomass threshold ($\frac{1}{2}TSB_{\text{MSY}}$) is 46,323 mt (Figures A2, A3).

Spawning stock biomass (SSB; Age 0+) declined 72% from 1983 to 1989 (18,800 mt to 5,200 mt), but with improved recruitment and decreased fishing mortality has increased to 38,600 mt in 2004 (Figure A2). Retrospective analysis shows a tendency to overestimate the SSB in the most recent years (Figure A4). The age structure of the spawning stock has expanded, with 75% at ages 2 and older, and 16% at ages 5 and older (Figure A5).

The arithmetic average recruitment from 1982 to 2004 is 38 million fish at age 0, with a median of 33 million fish. The 2004 year class is currently estimated to be at the median of 33 million fish (Figure A2, A6). Retrospective analysis shows that the current assessment method tends to overestimate the abundance of age 0 fish in the most recent years (Figure A4).

Forecasts for 2005-2006: Stochastic forecasts were conducted, incorporated uncertainty in 2005 stock sizes from survey variability, and assumed current discard to landings proportions. If landings in 2005 are 13,744 mt (30.2 million lbs) and discards are 1,269 mt (2.8 million lbs), the forecasts estimate a median F in 2005 = 0.40 and a median total stock biomass on January 1, 2006 of 59,900 mt, above the biomass threshold of $\frac{1}{2}TSB_{\text{MSY}} = 53,200$ mt. (Figure A3). Landings of 14,969 mt (33.0 million lbs) and discards of 1,400 mt (3.1 million lbs) in 2006 provide a median F in 2006 = 0.41 and a median total stock biomass level on January 1, 2007 of 63,800 mt (Figure A3). A subsequent reduction in fishing mortality in 2007 to $F = 0.263$, the reference point, is forecast to yield landings of 10,853 mt (23.9 million lbs).

Forecast Table: 2005 Landings = 13,744 mt
2005-2007 median recruitment from 1982-2004 VPA estimates (33.1million)

Forecast medians (landings, discards, and total stock biomass (TSB) in '000 mt)

2005				2006				2007			
TSB	F	Land	Disc	TSB	F	Land	Disc	TSB	F	Land	Disc
54.9	0.40	13.7	1.3	59.9	0.41	15.0	1.4	63.8	0.26	10.9	1.0

Catch and Status Table (weights in '000 mt, recruitment in millions, arithmetic means): Summer Flounder

Year	1998	1999	2000	2001	2002	2003	2004	Max ²	Min ²	Mean ²
Commercial landings	5.1	4.8	5.1	5.0	6.6	6.5	7.8	17.1	4.0	8.3
Commercial discards	0.4	1.5	0.7	0.5	0.4	0.5	0.2	1.5	0.2	0.7
Recreational landings	5.7	3.8	7.1	5.3	3.6	5.3	4.8	12.7	1.4	5.3
Recreational discards	0.5	0.7	0.9	1.2	0.7	0.7	1.0	1.2	0.1	0.5
Catch used in assessment	11.7	10.8	13.8	12.0	11.3	13.0	13.8	26.5	8.0	14.6
Commercial quota	4.9	4.9	4.9	4.6	6.6	6.3	7.6			
Recreational harvest limit	3.4	3.4	3.4	3.3	4.4	4.2	5.1			
Spawning stock biomass ¹	17.8	16.5	19.4	25.5	29.4	36.4	38.6	38.6	5.2	16.5
Recruitment (age 0)	31.0	29.4	35.9	32.8	38.1	27.5	33.1	80.3	13.0	38.0
Total stock biomass ³	32.0	29.1	27.9	31.4	39.5	46.4	53.1	53.1	16.1	32.7
F (ages 3-5)	0.97	0.99	0.86	0.65	0.46	0.43	0.40	2.07	0.40	1.32
Exploitation rate	57%	58%	53%	44%	34%	33%	30%	82%	23%	68%

¹At the peak of the spawning season (i.e., on November 1), ages 0-7+ . ²Over period 1982-2004 ³On January 1

Stock Distribution and Identification: The Mid-Atlantic Fishery Management Council (MAFMC) and Atlantic States Marine Fisheries Commission (ASMFC) Fishery Management Plan for summer flounder defines the management unit as all summer flounder from the southern border of North Carolina northeast to the US-Canada border. For assessment purposes, the definition of Wilk et al. (1980) of a unit stock extending from Cape Hatteras north to New England has been accepted in this and previous assessments (NEFSC 2002). A recent summer flounder genetics study, which revealed no population subdivision at Cape Hatteras (Jones and Quattro 1999), is consistent with the definition of the current management unit. A recent consideration of summer flounder stock structure incorporating new tagging data concluded that evidence supported the existence of stocks north and south of Cape Hatteras, with the stock north of Cape Hatteras possibly composed of two distinct spawning aggregations, off New Jersey and Virginia-North Carolina (Kraus and Musick, 2003). The conclusions of Kraus and Musick (2003) are consistent with the current assessment unit.

Catches: Total landings peaked in 1983 at 26,100 mt. During the late 1980s and into 1990, landings declined markedly, reaching 4,200 mt in the commercial fishery in 1990 and 1,400 mt in the recreational fishery in 1989. Total landings were only 6,500 mt in 1990. Reported 2004 landings in the commercial fishery were 7,748 mt, about 2% over the adjusted commercial quota. Commercial discard losses are estimated from fishery observer data and have recently

constituted 5%-10% of the total commercial catch, assuming a discard mortality rate of 80%. Estimated 2004 landings in the recreational fishery were 4,841 mt, about 5% under the recreational harvest limit. Recreational discard losses have recently comprised 10%-15% of the total recreational catch, assuming a discard mortality rate of 10%. Total commercial and recreational landings in 2004 were 12,589 mt, and total catch was estimated at 13,832 mt (Figure A1).

Data and Assessment: An analytical assessment (VPA) of commercial and recreational total catch at age (landings plus discards) was conducted. The natural mortality rate (M) was assumed to be 0.2. Indices of recruitment and stock abundance from NEFSC winter, spring, and autumn; Massachusetts spring and autumn; Rhode Island; Connecticut spring and autumn; Delaware; and New Jersey trawl surveys were used in VPA tuning in an ADAPT framework (NFT 2005). Recruitment indices from surveys conducted by the states of North Carolina, Virginia, and Maryland were also used in the VPA tuning. The current VPA tuning configuration is the same as that in the 2002 SAW 35 (NEFSC 2002) and in the 2003 and 2004 SAW Southern Demersal Working Group assessments (Terceiro 2003, SDWG 2004).

Biological Reference Points: Biological reference points for summer flounder are based on a yield per recruit model (Thompson and Bell 1934). The yield per recruit analysis conducted for the 1999 assessment (Terceiro 1999) indicated that $F_{\max} = 0.263$, which was used as a proxy for $F_{\text{threshold}}$ (Figure A3). No value for F_{target} has been defined for summer flounder. The current Fishery Management Plan (FMP) Amendment 12 stock biomass reference points were estimated as the product of yield per recruit (0.552 kg per recruit) and total stock biomass per recruit (2.813 kg per recruit) at $F_{\max} = 0.263$, and median recruitment of 37.8 million fish per year (1982-1998; from Terceiro (1999)). Yield at F_{\max} , used as a proxy for MSY , was estimated to be 20,900 mt (46 million lbs), and the corresponding stock biomass, used as a proxy for B_{MSY} , was estimated to be 106,400 mt (235 million lbs; Figure A3). In the review of the 2002 stock assessment, SARC 35 concluded that updating these reference points was not warranted at that time (NEFSC 2002).

For present assessment, updated input data (1992-2004 average mean weights, maturities, and partial recruitment) were used to revise the yield and biomass per recruit analysis. The updated 1982-2004 VPA provided an estimate of median recruitment for summer flounder of 33.1 million age 0 fish. The revised estimates of the biological reference points are $F_{MSY} = F_{\max} = 0.276$, $MSY = 19,072$ mt (42.0 million lbs), and $TSB_{MSY} = 92,645$ mt (204.2 million lbs). The revised estimate of the biomass threshold, $\frac{1}{2}TSB_{MSY}$, is 46,323 mt (102.1 million lbs).

Fishing Mortality: Fishing mortality calculated from the average of the currently fully recruited ages (3-5) was high during 1982-1997, varying between 0.9 and 2.2 (55%-83% exploitation), far in excess of the Amendment 12 overfishing definition, $F_{\text{threshold}} = F_{\max} = 0.26$ (21% exploitation; Figure A1). The fishing mortality rate has declined substantially since 1997 and was estimated to be 0.40 (30% exploitation) in 2004. The 80% confidence interval for F in 2004 ranged from 0.34 to 0.49. Retrospective analysis shows that the current assessment method tends to underestimate recent fishing mortality rates (Figure A4).

Total Stock Biomass: Total stock biomass has increased substantially since 1989, and in 2005 total stock biomass was estimated to be 54,900 mt, slightly above the Amendment 12 biomass threshold (Figures A2, A3). The 80% confidence interval for total stock biomass in 2005 ranged from 49,300 to 62,100 mt.

Recruitment: The arithmetic average recruitment from 1982 to 2004 is 38 million fish at age 0, with a median of 33 million fish. The 1982 and 1983 year classes are the largest in the VPA time series, at 74 and 80 million fish. Recruitment declined from 1983 to 1988, with the 1988 year class the weakest at only 13 million fish. Recruitment since 1988 has generally improved. The 2003 year class is currently estimated to be below average at 27 million fish. The 2004 year class is currently estimated to be at the median of 33 million fish (Figures A2, A6). Retrospective analysis shows that the current assessment method tends to overestimate the abundance of age 0 fish in the most recent years (Figure A4).

Spawning Stock Biomass: Spawning stock biomass (SSB; Age 0+) declined 72% from 1983 to 1989 (18,800 mt to 5,200 mt), but with improved recruitment and decreased fishing mortality has increased to 38,600 mt in 2004 (Figure A2). Retrospective analysis shows a tendency to overestimate the SSB in the most recent years (Figure A4). The age structure of the spawning stock has expanded, with 75% at ages 2 and older, and 16% at ages 5 and older (Figure A5). Under equilibrium conditions and at $F_{\max} = 0.263$ from Amendment 12, about 85% of the spawning stock biomass would be expected to be ages 2 and older, with 50% at ages 5 and older (Figure A5). Similar results for the long-term population structure are derived using the updated $F_{\max} = 0.276$.

Special comments: Major sources of assessment uncertainty

- 1) There is persistent retrospective underestimation of fishing mortality in the assessment.
- 2) The landings from the commercial fisheries used in this assessment assume no under reporting of summer flounder landings. Therefore, reported landings from the commercial fisheries should be considered minimal estimates.
- 3) The recreational fishery landings and discards used in the assessment are estimates developed from the Marine Recreational Fishery Statistics Survey (MRFSS). While the estimates of summer flounder catch are among the most precise produced by the MRFSS, they are subject to possible error. The proportional standard error (PSE) of estimates of summer flounder total landings in numbers has averaged 7%, ranging from 26% in 1982 to 3% in 1996, during 1982-2004.
- 4) The length and age composition of the recreational discards are based on data from a limited geographic area (Long Island, New York, 1988-1992; Connecticut, 1997-2004, New York party boats 2000-2004, ALS releases focused in New York and New Jersey, 1999-2004). Sampling of recreational fishery discards on an annual, synoptic basis is needed.

5) The allocation of commercial landings to water area and the measure of commercial fishing effort used in the estimate of discards both rely on information self-reported by commercial fishermen in Vessel Trip Reports (VTR), which are subject to possible error.

Sources of Information:

Jones, W.J., and J. M. Quattro. 1999. Genetic structure of summer flounder (*Paralichthys dentatus*) populations north and south of Cape Hatteras. *Marine Biology* 133: 129-135.

Kraus, R.T., and J. A. Musick. 2003. A brief interpretation of summer flounder, *Paralichthys dentatus*, movements and stock structure with new tagging data on juveniles. *Mar. Fish. Rev.* 63(3): 1-6.

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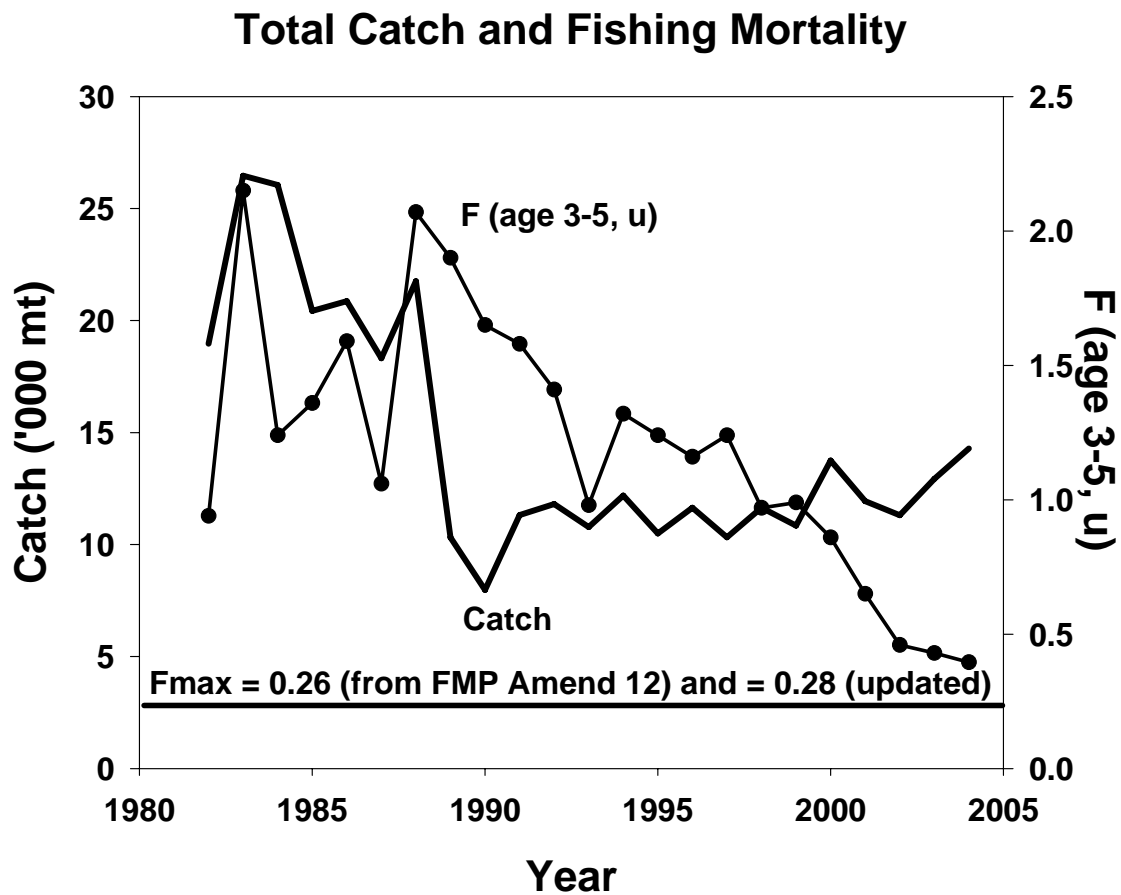
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Terceiro, M. 2003. Stock assessment of summer flounder for 2003. NEFSC Reference Document 03-09. 179 p.

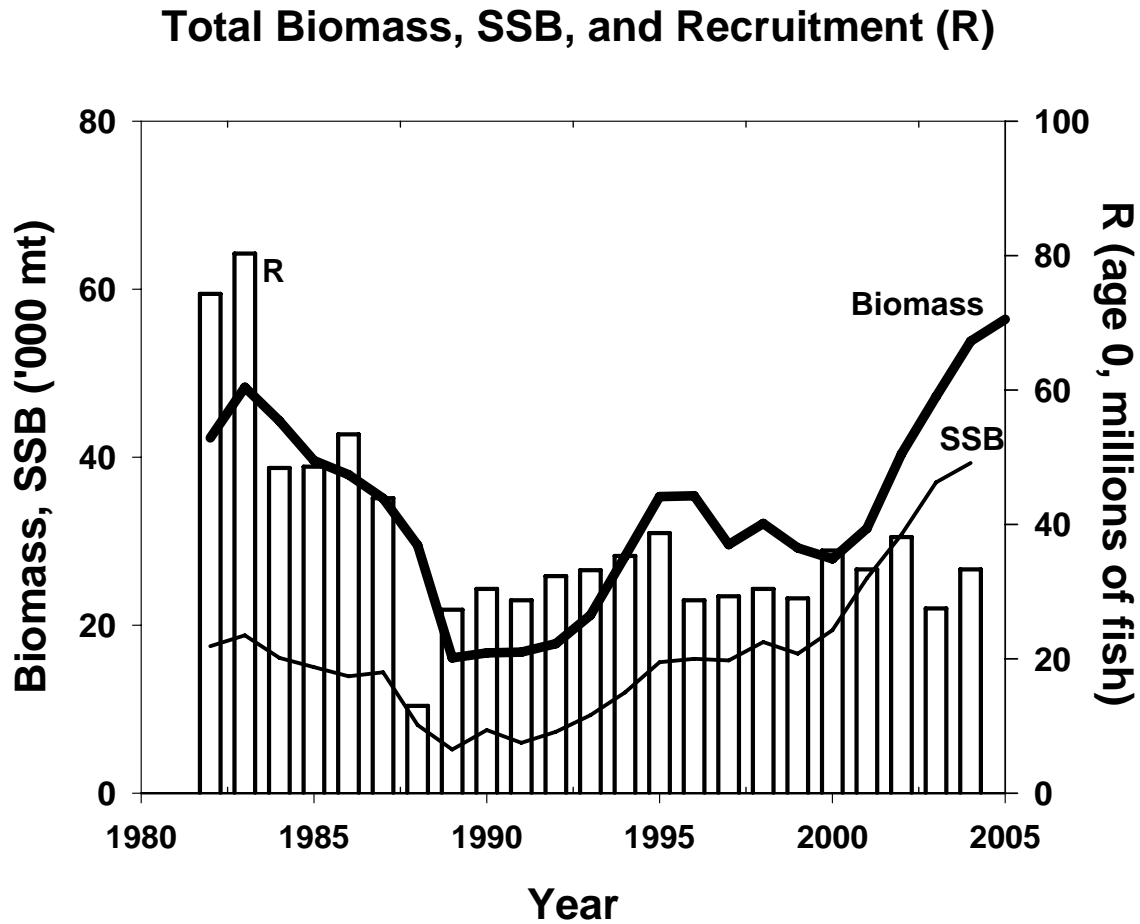
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Wilk, S.J., W. G. Smith, D.E. Ralph and J. Sibunka. 1980. The population structure of summer flounder between New York and Florida based on linear discriminant analysis. *Trans. Am. Fish. Soc.* 109:265-271.

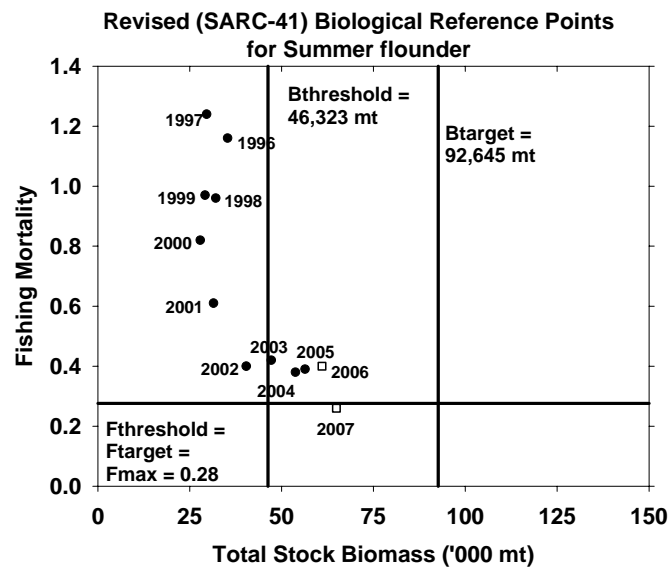
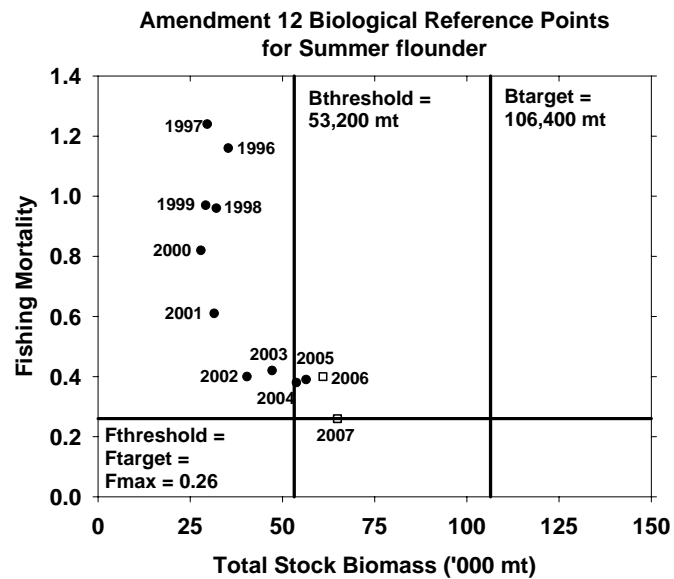
A1. Total catch (landings and discards, thousands of metric tons) and fishing mortality rate (F, ages 3-5, unweighted) for summer flounder.



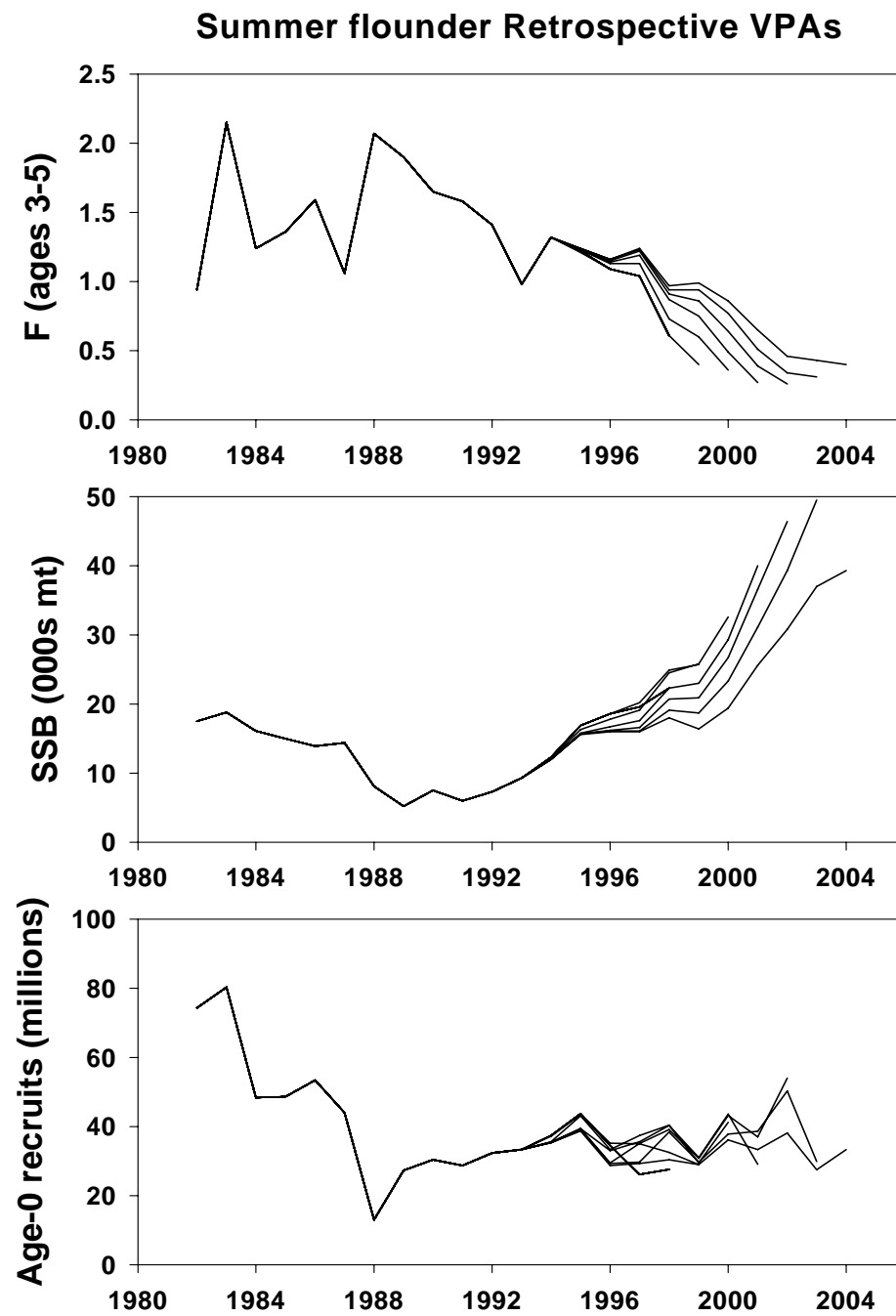
A2. Total stock biomass ('000 mt; thick line), spawning stock biomass (SSB, '000 mt; thin line), and recruitment (millions of fish at age-0; bars) for summer flounder by year.



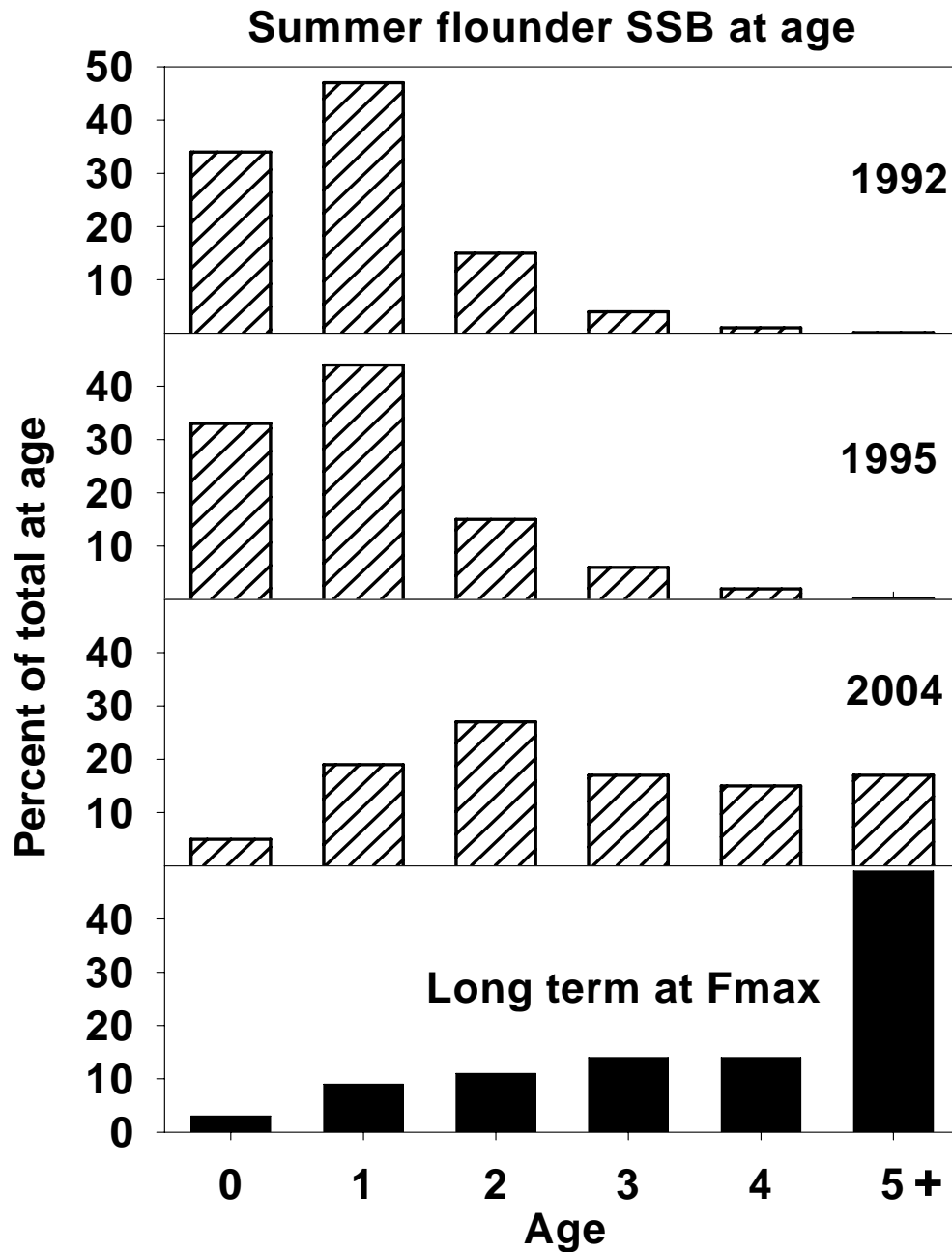
A3. Estimates of Biological Reference Points, biomass and F.



A4. Retrospective VPAs for summer flounder.



A5. Percent of summer flounder spawning stock biomass (SSB) at age in 1992, 1995, 2004 and long-term at $F_{max} = 0.263$. Similar long-term results are derived using updated $F_{max} = 0.276$.



A6. VPA spawning stock biomass and recruitment estimates for summer flounder.

